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16. Abstract

The final report for NASA Contract NAS 5-20064 "A Magnetic Field Investigation for ISEE Mother and Daughter Spacecraft" is contained herein. This contract supported the fabrication, test and integration of magnetometers on ISEE 1 and 2 and the reduction of the initial data until October 31, 1979. The initial operation was entirely successful.

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1. INTRODUCTION

This is the final report for NASA contract NAS 5-20064, "A Magnetic Field Investigation for ISEE Mother and Daughter Spacecraft". This investigation consisted of designing and fabricating magnetometers for two spacecraft ISEE A/B which were launched from a single vehicle into the same highly elliptic orbit in October 1977, and analyzing the data returned from these vehicles. Funding for this program began June 5, 1974, and ended on October 31, 1979.

2. MAGNETOMETER DESIGN AND TESTING

The magnetometer consisted of four basic assemblies: The sensors, the drive and sense electronics, the data handling unit, and the flipper. The flipper design had been previously used by the Ames Research Center Group on Imp D and E and was entirely successful. There were no anomalies in flight or in test. The ring core sensors used were purchased from the Naval Surface Weapons Laboratory and were as low noise and stable as advertised.

The basic circuits were tested for noise levels and linearity. The noise levels were below design goals and the linearity was better than we could measure with our present test set up (less than one part in a thousand). The digital data handling assembly had one novel feature, a digital filter that maintained a uniform transfer function for all three axes and for both spacecraft. Further design details are contained in Appendix 1 which is a paper describing the magnetometer.

3. INITIAL OPERATION

The magnetometer was designed with a single precision (8-bit) and a double precision (16-bit) mode. This design feature was to enable us to trade accuracy for speed when desired. In practice we chose the accuracy option and operated the magnetometer continuously in the double precision mode after the first month. Flips were made weekly at first. Then we decided that the magnetometers were stable enough to depend on only monthly flips. The magnetometers have operated continuously since launch except for turn-offs during eclipses.

4. INITIAL SCIENTIFIC RESULTS

The first scientific efforts with the magnetometers centered on the bow shock (Russell and Greenstadt, 1979) and the magnetopause (Russell and Elphic, 1978). These studies showed both boundaries to be in rapid motion. The bow shock was found to be very thin, close to an ion inertial length in thickness but the magnetopause was much thicker than expected, about 400 - 1000 km on average. Another strange phenomenon was found on the magnetopause, the flux transfer event which is the signature of patchy reconnection. Later studies focussed on upstream waves, interplanetary shocks, magnetic pulsations and the magnetotail. For more detail see the papers listed in Appendix B.

5. CONCLUSIONS

The two ISEE fluxgate magnetometers supplied by this contract by many measures rank among the most successful instruments launched by NASA into space. At this writing they have each logged over 3 2/3 years of continuous successful operation. Their measurements have been used in over 120 papers presented at meetings and have been used in over 55 papers published in journals and books.

6. REFERENCES

Russell, C.T. and R.C. Elphic, Initial ISEE magnetometer results: Magnetopause observations, Space Science Reviews, 22, 681-715, 1978.

Russell, C.T. and E.W. Greenstadt, Initial ISEE magnetometer results: Shock observations, Space Science Reviews, 23, 3-37, 1979.

Appendix A

The ISEE 1 and 2 Fluxgate Magnetometers